

N65-23189

HEC-D042  
VOLUME VII

N65 23189

FACILITY FORM 002

(ACCESSION NUMBER)

(PAGES)

CR 62514  
(NASA CR OR TMX OR AD NUMBER)

(THRU)

(CODE)

(CATEGORY)

SA-9

# VEHICLE AND LAUNCH COMPLEX FUNCTIONAL DESCRIPTION

## LAUNCH PAD ACCESSORIES

GPO PRICE \$ \_\_\_\_\_

OTS PRICE(S) \$ \_\_\_\_\_

Hard copy (HC) 2.00

Microfiche (MF) 50

SPACE DIVISION



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HUNTSVILLE OPERATIONS

SGT-24136



**HEC-D042  
VOLUME VII**

**SA-9  
VEHICLE AND LAUNCH COMPLEX  
FUNCTIONAL DESCRIPTION  
LAUNCH PAD ACCESSORIES**

**APRIL 1964**

**ENGINEERING COMMUNICATIONS DEPARTMENT**

**SPACE DIVISION**



**CHRYSLER  
CORPORATION**

**HUNTSVILLE OPERATIONS**



## FOREWORD

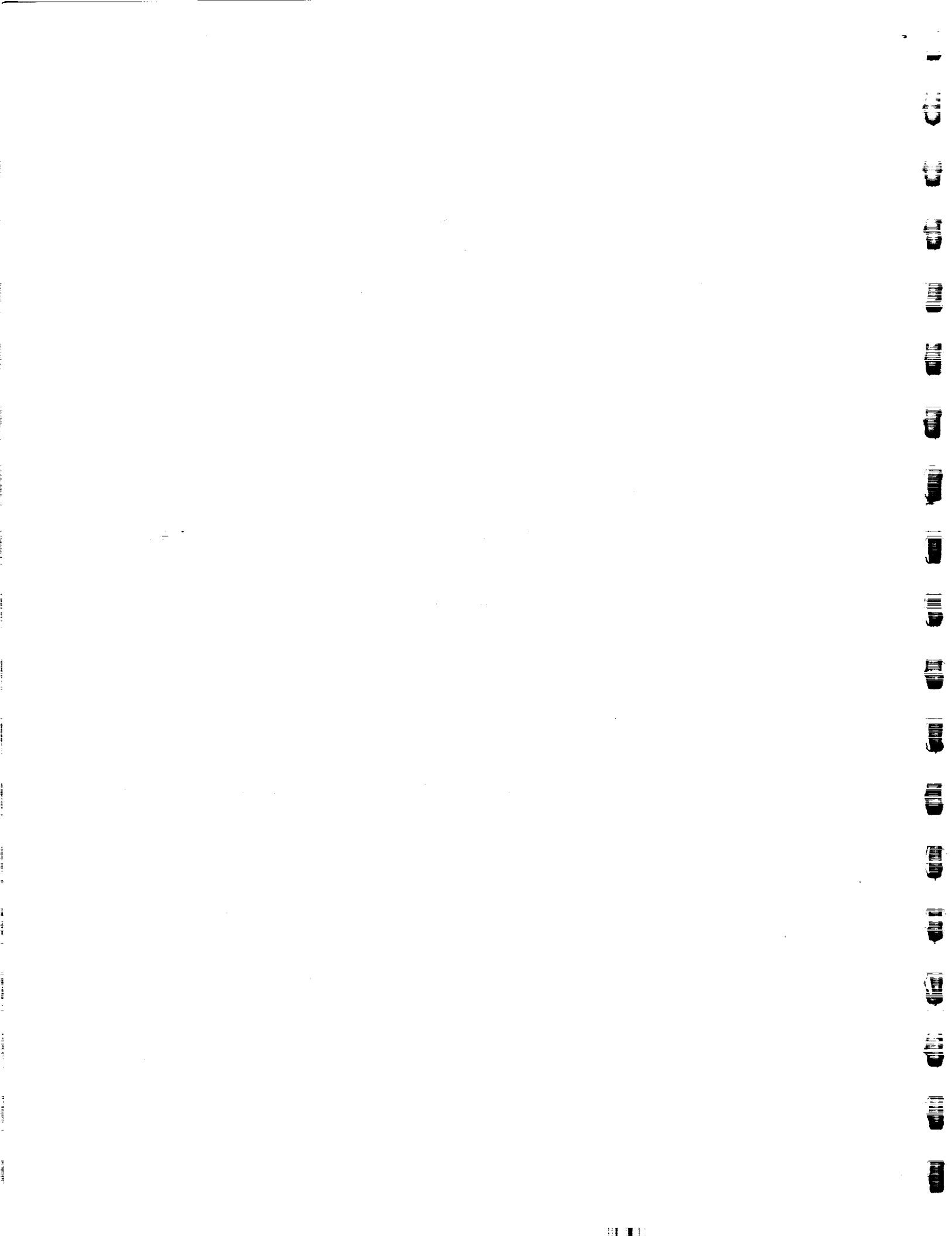
This volume has been prepared for the Functional Integration Section, Systems Integration and Operations Branch, Vehicle Systems Division, Propulsion and Vehicle Engineering Laboratory, by the Engineering Communications Department, Chrysler Corporation Space Division, under contract number NAS8-4016.

The following series, of which this volume is a part, functionally describes the mechanical and electromechanical systems of Saturn I, SA-9 space vehicle and Launch Complex 37:

Volume I.	RP-1 Fuel System
Volume II.	LOX System
Volume III.	LH <sub>2</sub> System
Volume IV.	Nitrogen and Helium Storage Facility
Volume V.	Pneumatic Distribution System
Volume VI.	Environmental Control System
Volume VII.	Launch Pad Accessories
Volume VIII.	H-1 Engine and Hydraulic System
Volume IX.	RL10A-3 Engine and Hydraulic System
Volume X.	Separation and Flight Termination Systems
Volume XI.	Supplement: Legend and Composite Schematic

Each volume contains mechanical schematics and a list of applicable finding numbers.

Volume VII describes those components that are active during launch operations: the umbilical tower swing arms, short cable masts, fuel and LOX masts, and holddown arms. This volume specifically excludes launch pad accessories for the payload (Apollo Spacecraft) and maintenance and checkout procedures. Only information available by December 5, 1963, has been included.



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## 1. UMBILICAL TOWER SWING ARMS

### 1.1. Swing Arm Description

Three swing arm assemblies on the umbilical tower (figure 1) support the electrical cables, hydraulic and pneumatic lines, and air conditioning ducts that service the S-I stage, the S-IV stage, and the instrument unit of the Saturn vehicle during prelaunch operations. Swing arm number one, located between the 108 and 118 foot levels, services the S-I stage; number two, between the 128 and 138 foot levels, the S-IV stage; and number three, between the 158 and 168 foot levels, the instrument unit. Swing arm number two also supports the S-IV stage propellant loading lines. At vehicle liftoff, the umbilical housings and connector plate disconnect from the vehicle and the swing arms rotate laterally out of the vehicle flight path.

Solenoid-controlled pneumatic pressure actuates the umbilical housing release mechanism and the kickoff cylinders, releasing the umbilical housings and pushing them away from the vehicle. The swing arms are rotated away from the vehicle by hydraulic rotary actuators. The hydraulic systems are filled by a hydraulic power cart located in automatic ground control station and are pressurized by pneumatic pressure from valve panel 5. Automatic release of the umbilical housings and rotation of the arms at liftoff is initiated by a liftoff switch on the holddown arms; however, each swing arm can be operated from a control panel located on the tower adjacent to that arm.

Each swing arm system consists of a basic arm, hinge assembly, quick-release mechanism, rotary actuator assembly, bumper assembly, and control panel.

1.1.1. Basic Arm. The basic arm is a four-sided truss structure with an attachment plate assembly at each end. The main attachment plate is secured to the tower by a hinge assembly. The plate on the vehicle end of the basic arm attaches extension arms to swing arms number two and three. A sheet metal tray supports the various service lines on the swing arm.

1.1.2. Hinge Assembly. The hinge assembly connects to the back plate weldment that attaches to the umbilical tower. The rotating elements of the assembly contain twin-row, spherical, self-aligning roller bearings with spacers on either side of each bearing race. A lock-pin assembly on the bottom hinge holds the arm in the servicing position, preventing arm rotation.

The lock-pin cylinder contains a compression coil spring, which holds the piston in the extended (locked) position until hydraulic pressure is applied. When the lock-pin is retracted, it mechanically opens a ball valve in the hydraulic supply line. This valve ensures that the lock-pin is retracted and the swing arm is free to rotate before hydraulic pressure is applied to the lanyard retract cylinder and the rotary actuator unit.

A ball valve on the stationary part of the top hinge is actuated by a cam plate that rotates with the top hinge. As the arm rotates away from the vehicle, the cam closes the ball valve and restricts flow in the hydraulic return line, thus decelerating the arm prior to arm contact with the bumper assembly.

1.1.3. Quick-Release Mechanism. The quick-release mechanism at the outer extremity of the swing arm assembly connects and secures service lines to the vehicle during ground servicing operations, and releases and ejects these lines at vehicle liftoff. Due to the number and size of the service lines, arms one and three employ a quick-release housing. A ball-lock assembly, positioned in a lock ring, secures the housing to the vehicle umbilical plate. Two housing support legs resting on vehicle pin devices help support the weight of the housing and synchronize the release of the couplings at disconnect. At liftoff, pneumatic pressure retracts the lock pin and actuates four kick-off pistons, separating the housing from the vehicle. Arm number two uses a connector plate assembly secured to the vehicle by two ball-lock kickoff cylinders. The ball-lock cylinders are positioned on and locked to two retaining knobs on the vehicle umbilical plate. At liftoff, pneumatic pressure actuates the ball-lock kickoff cylinders and separates the connector plate from the vehicle.

The GH<sub>2</sub> vent line, installed on swing arm number three, is connected to the S-IV stage by a 6-inch quick-disconnect coupling assembly. The coupling is secured to the stage by a spring-lock assembly inside the coupling. At liftoff, pneumatic pressure actuates two kickoff cylinders, attached to the outer shell of the coupling assembly, which separate the vent line from the vehicle.

In the event pneumatic pressure fails to release any of the umbilical connectors from the vehicle, they are mechanically released by the pull of the lanyard retract cables, which connect to a hydraulic cylinder and piston assembly. When the swing arm lock pin is retracted, it opens a ball valve in the hydraulic supply line and allows hydraulic pressure to force the piston to the bottom of the lanyard retract cylinder. The downward force of the piston, acting through the lanyard cables, pulls the umbilical housing (or connector plate) away from the vehicle.

1.1.4. Rotary Actuator Assembly. The hydraulic rotary actuator assembly provides the necessary torque to rotate the swing arm from the servicing position to the retracted position (against the tower) quickly enough to prevent the vehicle from striking the swing arm at liftoff.

The rotac (hydraulic rotary actuator) consists of a cylindrical housing that contains a fixed vane and, attached to a shaft, a rotary vane. These vanes extend radially outward from the center of the cylinder to the cylinder wall, dividing the cylinder into two parts. The hydraulic supply line connects to one part and the hydraulic return line connects to the other. As hydraulic pressure acts against the supply side of the cylinder, the rotary vane and its shaft in the center of the cylinder are forced to rotate. The shaft is rigidly attached to the basic arm structure; therefore, the rotating shaft swings the arm away from the vehicle. With a pressure differential of 1500 psig between the two sections of the rotac cylinder, the rotac develops 210,000 inch-pounds of torque.

1.1.5. Bumper Assembly. A bumper assembly for each arm on the umbilical tower provides a rigid stop for the swing arms after approximately 135 degrees of rotation. Basically, the bumper assembly is a channel beam mounted vertically on the tower and installed so that the forward end of the swing arm will contact the bumper. Rubber pads cover the arm contact area on the bumper to prevent damage to the arm. A microswitch, mounted on each bumper assembly, contains a built-in plunger that extends through the bumper. Arm contact with the plunger actuates the switch, which transmits a signal to the launch control center, indicating that the arm is fully retracted.

1.1.6. Control Panels. On the umbilical tower, adjacent to each swing arm, a panel contains the equipment necessary to control the swing arm pneumatic and hydraulic systems. Hydraulic and pneumatic accumulators in each control panel provide a means of precharging the system prior to launch.

Each control panel contains a hand-operated shutoff valve, a pressure regulator, a pressure gage, and a hand-operated vent valve that control the pneumatic pressure within the system. Solenoid valves within the control panel control the pneumatic pressure supplied to the quick-release housing and the pneumatically operated ball valves in the hydraulic system. These solenoid valves, which are actuated automatically at liftoff, can be actuated with a toggle switch on the panel. The hydraulic system is controlled from the panel by a hand-operated shutoff valve, a 4-way 3-position valve, and several push-button valves. The hydraulic supply lines contain pneumatically operated ball valves. The pneumatic actuation pressure for these valves is controlled by the solenoid valves.

The control panels are constantly purged with 50-psig GN<sub>2</sub> during their operation.

## 1.2. Swing Arm Operation

Operation of the arms involves: system preparation, rotation into vehicle servicing position, and umbilical release and swing arm rotation at liftoff. Because the three swing arms operate in essentially the same manner (the only difference being that swing arm number two has a connector plate rather than an umbilical housing), only swing arm number one is described. Figure 3, page 37, represents the swing arm number one hydraulic and pneumatic systems and should be used in connection with the text.

1.2.1. System Preparation. Before the swing arm can be operated, Hydraulic Accumulator A3000 must be filled and then the pneumatic system pressurized.

The hydraulic accumulator is filled as follows:

- a. The hydraulic pump motor on Hydraulic Power Cart A4850 is started and the flow control valve on the cart is opened. Hydraulic fluid is then pumped into the tower hydraulic supply line.
- b. Manual Tower Valve A5500 is opened and hydraulic fluid flows through Filter A3020 and Check Valve A3003 into the accumulator.
- c. The accumulator is filled until the fluid forces a piston within the accumulator to the top and actuates Accumulator Full Indicator Switch A3022.
- d. When pump pressure builds up to 1700 psig, the pump shuts off.

The pneumatic system is pressurized as follows:

- a. Pneumatic Shutoff Valve A3001 on the swing arm control panel is opened, allowing 3000-psig GN<sub>2</sub> from valve panel 5 to flow through Check Valve A3027 to Pneumatic Regulator A3006.
- b. Pneumatic Regulator A3006 is opened slowly until Pneumatic Accumulator A3002 is pressurized to the prescribed operating pressure of 1500 psig, as indicated by Pressure Gage A3005 and signaled by Pressure Switch A3047. When the prescribed pressure is reached, Pneumatic Shutoff Valve A3001 is closed. If re-charging is necessary after the tower has been cleared, Solenoid Valve A3042 can be remotely opened to bypass the pneumatic shutoff valve.
- c. A hand-operated shutoff valve is opened on valve panel 5 to purge the umbilical housing and supply 750-psig GN<sub>2</sub> for valve actuation and umbilical housing release.

1.2.2. Rotation into Vehicle Servicing Position. To service the vehicle, the swing arm must be rotated into position and the umbilical housing secured to the vehicle as follows:

- a. A toggle switch on the swing arm control panel is moved to the closed position. The switch energizes normally closed Solenoid Valve A3018, allowing 750-psig pneumatic pressure to close Ball Valves A3012 and A3036 in the hydraulic supply line.
- b. Manual Valve A3007 is opened, allowing hydraulic fluid to flow to 4-way, 3-position Valve A3008, which is positioned to direct

hydraulic fluid to the side of Hydraulic Rotary Actuator A3013 that will rotate the swing arm toward the vehicle. As the arm rotates, the hydraulic fluid in the other side of the rotary actuator cylinder flows back through the 4-way, 3-position valve into the hydraulic return line.

- c. When the arm reaches a neutral position, the 4-way, 3-position valve is moved to the center (closed) position and Push-Button Valve A3026 is opened. Opening of Valve A3026 allows the hydraulic fluid within Lock-Pin Assembly A3021 to flow into the hydraulic return line. This allows the locking pin to extend and lock the swing arm in the servicing position.
- d. Push-Button Valve A3009 is opened momentarily to retract the lock pin just enough to open Ball Valve A3023. Then the piston within Lanyard Retract Cylinder A3011 is manually extended while hydraulic fluid is forced from the cylinder through Orifice A3078, Ball Valve A3023, and Orifice A3035 into the hydraulic return line. Then Manual Valve A3009 is closed.
- e. After the lanyard cable and piston have been extended, Umbilical Housing A3060 is positioned against the vehicle umbilical plate and secured to the vehicle by positioning a ball-lock assembly in a lock ring on the vehicle umbilical plate.
- f. Hydraulic and Pneumatic Accumulators A3000 and A3002 are recharged and Solenoid Valve A3018 is closed. The swing arm is now ready for vehicle servicing and automatic retraction at liftoff.

1.2.3. Umbilical Release and Swing Arm Rotation at Liftoff. At liftoff, the umbilical housing is released and pulled away from the vehicle and the swing arm is rotated out of the vehicle flight path automatically upon receipt of a signal from any one of the liftoff switches located on the holddown arms.

- a. The signal from a liftoff switch opens Solenoid Valve A3039 and allows 750-psig GN<sub>2</sub> flow to the release mechanism and kickoff cylinders of Umbilical Housing A3060. The release mechanism and kickoff cylinders release the umbilical housing and separate it from the vehicle.
- b. The same signal from the liftoff switch opens Solenoid Valves A3017 and A3041, allowing 750-psig pneumatic pressure to open Ball Valves A3012 and A3036 in the hydraulic supply line. Hydraulic fluid at 1500 psig flows through Check Valve A3004 and into Swing Arm Lock-Pin Assembly A3021, retracting the locking pin and freeing the swing arm for rotation.
- c. As the lock pin retracts, Ball Valve A3023 opens. Hydraulic fluid flows through Orifice A3078 into Lanyard Retract Cylinder A3011 and also through Check Valve A3031 into Hydraulic Rotary

Actuator A3013. The lanyard retract cylinder pulls the umbilical housing and service lines from the vehicle while the rotary actuator begins swing arm rotation.

- d. As the arm completes 55 degrees of rotation, Ball Valve A3032 is slowly closed by a cam on the top hinge assembly. The closing of this valve restricts the flow of hydraulic fluid from the return side of Hydraulic Rotary Actuator A3013, decelerating the arm. After the arm completes approximately 90 degrees of rotation, Ball Valve A3032 closes completely, further decelerating the arm by forcing the hydraulic fluid to flow through Orifice A3044. Relief Valve A3067 prevents excessive pressure buildup in the hydraulic return line. The hydraulic fluid flows through Orifice A3077 into the tower hydraulic return line.
- e. When the arm completes 130 to 135 degrees of rotation, the arm contacts the tower bumper assembly. A microswitch in the bumper assembly signals the launch control center that the swing arm is fully retracted.

## 2. SHORT CABLE MASTS

### 2.1. Short Cable Mast Description

Two short cable masts (figure 2) provide a structural support and a disconnect capability for electrical cables and pneumatic service lines required for checkout and operation of the Saturn vehicle engine components prior to launch. At liftoff, after the vehicle is approximately two inches off the pad, the masts disconnect all cables and lines and rotate in a vertical plane away from the flight path of the vehicle.

The masts are designated short cable masts number two and number four, indicating their locations next to fins II and IV. The two masts are similar in construction and operation, the principal differences being the type, size, and quantity of cables and pneumatic lines required at each fin location. Each short cable mast system consists of a support platform and mast weldment, kickoff cylinders, a quick-release housing, a retract cylinder, a latch-back mechanism, and a trunnion. The actuating mechanisms and structural arrangement of masts number two and four are identical.

2.1.1. Support Platform and Mast Weldment. The support platform, manufactured from steel tubing and plate, provides elevation and structural support for the mast. Three access platforms, mounted on each support platform and removed before launch, allow personnel to operate and service the short cable masts.

The mast weldment extends from the support platform to the vehicle umbilical area. The upper portion of the weldment accommodates the quick-release

housing; the lower portion accommodates the retract cylinder and allows for extension or retraction of the weldment.

2.1.2. Kickoff Cylinders. Two spring-loaded kickoff cylinders mechanically eject the quick-release housing from the vehicle. The cylinders are secured to the upper bracket arms of the mast weldment by special hinges and are inserted in special pin-holddown devices on the vehicle. At liftoff, vehicle motion forces the pistons to compress the springs. After two inches of vertical motion, the pistons bottom within the cylinders and push the mast away from the vehicle. The kickoff cylinders are also used in prelaunch testing of the mast by pressurizing the cylinders to eject the mast and the quick-release housing.

2.1.3. Quick Release Housing. In the upper end of the mast weldment, a quick-release housing contains all electrical cables and pneumatic service line connectors that link the vehicle with the ground servicing systems. A ball-lock and release pin assembly holds the housing in position. A release arm is attached to one end of the pin assembly and a roller is mounted on the other end. As the vehicle lifts approximately two inches, the roller moves down a groove in the mast arm and encounters a cam, which pivots the release arm about a pin, forcing the release pin assembly to retract. This frees the quick-release housing from the vehicle. During prelaunch checkouts, the ball-lock and release pin assembly releases pneumatically.

2.1.4. Retract Cylinder. A double-acting, pneumatic retract cylinder supplies the force that retracts the cable mast during launch. At T-5 seconds, 750-psig GN<sub>2</sub> is applied to the top of the retract cylinder and is opposed by constantly-venting 50-psig GN<sub>2</sub> at the bottom of the cylinder. This opposing pressure cushions the mast at the end of its retraction. A secondary signal, sent to a separate valve simultaneously with the commit signal, results in another supply of 750-psig GN<sub>2</sub> to the top of the cylinder during retraction.

2.1.5. Latch-Back Mechanism. A latch-back mechanism, bracketed between the mast weldment and the trunnion, provides a positive lock for the mast in any of the three retracted positions. This lock keeps the mast from rebounding into the vehicle flight path. The first position holds the mast about four inches from the vehicle to prevent its striking the vehicle during manual erection. The middle latch position secures the mast out of the anticipated vehicle drift envelope. The kickoff cylinders should force the mast to this position even if a failure occurs in the pneumatic retraction system. The third position latches the mechanism in the fully retracted position.

2.1.6. Trunnion. The trunnion provides a mounting point and a pivot for the mast weldment and allows vertical mast adjustment. A latch bracket and retraction cylinder pivot brackets are mounted on the trunnion.

## 2.2. Short Cable Mast Operation

Mast number two and mast number four operate identically; therefore, only the operation of mast number two is discussed. Figure 5, page 41,

represents the short cable mast system and should be used in conjunction with the text.

#### 2.2.1. Mast Erection

- a. The latch mechanism is released and the mast moved manually toward the vehicle.
- b. Kickoff Cylinders A6511 and A6526 are inserted into vehicle pin holddown devices.
- c. Vent Port Check Valve A6523 is removed and a variable (250 to 750 psig) GN<sub>2</sub> supply is attached to Orifice A6516 to supply pneumatic pressure to the bottom of Retract Cylinder A6522.
- d. As the retract cylinder is gradually pressurized, the mast moves closer to the vehicle and Ball-Lock Release Pin A6500 is guided into the vehicle plate receptacle. The kickoff cylinders compress further as the mast moves toward the vehicle.
- e. The housing is secured to the vehicle plate and pressure is bled from the auxiliary pneumatic line and the retraction cylinder. Then the auxiliary line is removed and Vent Port Check Valve A6523 is reinstalled.
- f. All service lines are connected to their proper nipples and connectors on the quick-release housing, and are secured.

#### 2.2.2. Automatic Mast Retraction

- a. At T-5 seconds, Solenoid Valve A5602 opens, allowing 750-psig GN<sub>2</sub> flow through Check Valve A6514 to prepressurize the upper part of Retract Cylinder A6522. The pneumatic pressure also flows through Pressure Regulator A6518 and Check Valve A6517 into the lower part of the retract cylinder. Pressure in the bottom of the retract cylinder vents through Orifice A6516 and Check Valve A6523. A secondary signal, concurrent with the launch commit signal at T+3.75 seconds, opens Solenoid Valve A5603, allowing 750-psig GN<sub>2</sub> backup pressure to flow through Check Valve A6520 into the mast retract system.
- b. At liftoff, the quick-release housing (still in servicing position) will move up with the vehicle.
- c. The vehicle ends of Kickoff Cylinders A6511 and A6526 also move up with the vehicle, further compressing the kickoff cylinder springs.
- d. The roller on the release arm of the quick-release housing moves along the mast arm slot. After approximately two inches of vehicle motion, the release arm pivots and disengages Ball-Lock

and Release Pin Assembly A6500, releasing the quick-release housing. Simultaneously, the pistons within the kickoff cylinders bottom and provide an outward force on the mast weldment.

- e. The kickoff cylinders provide enough outward force to disconnect the cable and line connectors from the vehicle. The springs within the cylinders help to accelerate the mast away from the vehicle.
- f. As disconnect occurs, Retract Cylinder A6522 pulls the mast away from the vehicle. Constantly-venting 50-psig GN<sub>2</sub> in the bottom of the retract cylinder cushions mast travel.
- g. As the mast reaches the end of its travel, the latch-back mechanism engages, preventing the mast from rebounding into the vehicle flight path or, in the event of pneumatic failure, from falling back into the vehicle.

### 3. FUEL AND LOX MASTS

#### 3.1. Fuel and LOX Mast Description

The fuel and the LOX masts (figure 2) are pivoting structures that provide the final link between the propellant transfer lines and the vehicle filling nozzles. The fuel mast is installed between fin I and stub fin I, the LOX mast between stub fin II and fin III.

The basic structural configuration and operation of the masts are the same, the principal differences being that the fuel mast is eighteen inches longer and contains a turbine exhaust duct. Manual control for mast erection and retraction is provided by a pneumatic valve box mounted on each mast support stand. Automatic retraction at liftoff is provided by an electrically controlled pneumatic system.

Each mast consists basically of a retractable coupling assembly, cylinder assemblies, retracting assembly, mast arrestor, mounting assembly, valve box assembly, and pneumatic lines.

3.1.1. Retractable Coupling Assembly. The retractable coupling assembly is a mechanically actuated, telescoping device that mates the mast to the vehicle filling nozzle. The coupling assembly consists primarily of a guide assembly and a bellows assembly mounted in a shield assembly. The guide assembly aligns the coupling assembly with the vehicle filling nozzle during mast erection. The bellows assembly consists of an inner sleeve weldment, bellows, and outer sleeve assembly that are mounted inside the shield so that the shield assembly and outer sleeve will telescope over the inner sleeve weldment when an external force is applied. This configuration provides

leak-free passage of propellant to the vehicle. During erection, the bellows is compressed by two spring-loaded pneumatic cylinder assemblies under 750-psig GN<sub>2</sub> pressure. When the pressure is vented from these cylinders, the recoil forces of the bellows, combined with the forces of the spring-loaded cylinders, force the coupling assembly over the vehicle nozzle. A teflon seal in the retractable coupling assembly provides a positive seal with the vehicle filling nozzle. During retraction operations before launch, the coupling assembly retracts pneumatically. Vehicle motion at liftoff provides adequate clearance for mast retraction. The flexibility of the coupling assembly prevents damage to the mast during launch operations.

3.1.2. Cylinder Assemblies. Two cylinder assemblies on each mast retract and extend the retractable coupling assembly. Each cylinder assembly consists primarily of two clevises, a piston rod, a spring, a pressure port, and a cylinder body. One clevis connects the piston to the retractable coupling assembly; the other connects the cylinder body to the upper pipe weldment. The spring in the cylinder is preloaded to maintain the piston (with the retractable coupling assembly attached) in the extended position. To retract the coupling assembly, 750-psig GN<sub>2</sub> enters the cylinder through a port above the piston and forces the piston downward within the cylinder. When the cylinder is vented, the spring and bellows extend, returning all components to their normal (extended) positions.

3.1.3. Retracting Assembly. The retracting assembly, an adjustable pneumatic cylinder, pivots the upper portion of the mast into position under the vehicle nozzle; or, upon signal, rotates the mast away from the vehicle. The retracting assembly consists of a pneumatic cylinder, an adjustment wheel, a clevis, and an upper and a lower pneumatic port. The cylinder support is attached to a trunnion support on the mounting assembly, and the clevis connects the pneumatic cylinder piston rod to a support bracket on the upper mast. 750-psig GN<sub>2</sub>, applied through the upper pneumatic port, forces the piston downward. This force, transmitted through the piston rod to the support bracket, pivots the mast away from the vehicle. GN<sub>2</sub>, supplied at approximately 180-psig through the lower pneumatic port, decelerates and cushions the mast during retraction.

Applying pneumatic pressure to the lower pneumatic port and venting the upper portion of the cylinder, returns the mast to the erect position. The adjustment wheel is used to align the mast with the vehicle nozzle.

3.1.4. Mast Arrestor. The mast arrestor automatically secures the mast in its retracted position, preventing the mast from rebounding into the vehicle flight path or falling back into the vehicle should pneumatic failure occur during liftoff. The arrestor consists of a mounting bracket that attaches to the retracting assembly pneumatic cylinder, a dual arrestor hook, and an arrestor pneumatic cylinder, spring-loaded to the arresting position. The spring load of the arrestor pneumatic cylinder retains the hook in the locked position until pneumatic pressure overcomes the spring tension and pivots the hook to its released position.

3.1.5. Mounting Assembly. The mounting assembly, the connecting link between the upper and lower pipe weldments, is secured to the support stand. It has a trunnion support to which the retracting assembly and support brackets are connected; an adjustment ring, which provides height adjustment of the mast to attain the correct clearance between the retractable coupling assembly and vehicle filling nozzle; and adjustment screws, which allow lateral adjustment of the mast.

3.1.6. Valve Box Assembly. The valve box assembly on the support stand provides manual and automatic control of pneumatic pressure for mast operation. Manual control of pneumatic circuits for mast erection, retraction, and checkout utilizes button-operated valves mounted through an access panel. The valve box also contains a multi-ported manifold, orifices, check valves, a regulator, relief valves, and pneumatic tubing. Pneumatic pressure for automatic retraction of the mast at liftoff is controlled by a normally-closed solenoid valve in the launcher pedestal valve box.

3.1.7. Turbine Exhaust Duct. The turbine exhaust duct on the fuel mast support structure provides a vent through the fuel mast assembly for hot gases from the turbine of H-1 engine number five. The duct collects and routes the exhaust gases through the mast support stand to the atmosphere.

### 3.2. Fuel and LOX Mast Operation

The fuel and LOX masts are erected prior to launch and aligned by using the valve box assembly on the mast support stand. The masts retract automatically at launch. Since the two masts operate in the same manner, only the fuel mast operation is discussed. Figure 5, page 41, represents the fuel and LOX mast systems and should be used in conjunction with the text.

3.2.1. Fuel Mast Erection. The fuel mast assembly is erected to the servicing position as follows:

- a. Button-Operated Valve A4511 on the valve box assembly is opened, allowing 750-psig  $\text{GN}_2$  flow through Check Valve A4515 into Cylinder Assemblies A4502 and A4503. These cylinder assemblies then retract Retractable Coupling Assembly A4500. The  $\text{GN}_2$  also flows to mast Arrestor Cylinder A4508, releasing the mast arrestor mechanism. Simultaneously, 750-psig  $\text{GN}_2$  flows through Check Valve A4512, Orifice A4527, and the retract port of Retract Cylinder A4504, holding the mast in its retracted position.
- b. Button-Operated Valve A4511 is closed, trapping the pneumatic pressure within the system to keep the coupling assembly and the mast assembly in the retracted position.
- c. Button-Operated Valves A4514 and A4516 are opened. These valves are mechanically linked and are actuated by a single control. Opening these valves supplies 750-psig  $\text{GN}_2$  to the erect port of Retract Cylinder A4504 and vents the pneumatic

pressure from the retract port of the retraction cylinder through Orifice A4513 and Vent Valve A4514. The mast then moves slowly into position under the vehicle filling nozzle, with the coupling assembly still in the retracted position.

- d. Button-Operated Valves A4514 and A4516 are closed when the mast reaches the erect (servicing) position, with the retractable coupling assembly directly under the vehicle filling nozzle.
- e. Button-Operated Vent Valve A4521 is opened, venting the entire mast assembly. Venting of Cylinder Assemblies A4502 and A4503 allows the springs within the cylinders to extend the retractable coupling assembly, thereby mating the coupling assembly to the vehicle filling nozzle. The venting of mast Arrestor Cylinder A4508 allows the arrestor hook to return to its normal (arresting) position.

3.2.2. Automatic Mast Retraction. Automatic mast retraction at launch occurs as follows:

- a. A holddown-arm release signal actuates Solenoid Valve A5601 on the launcher, allowing 750-psig GN<sub>2</sub> flow through Check Valve A4523 to the retract port of Retract Cylinder A4504.
- b. The 750-psig pneumatic pressure forces the piston to the bottom of Retract Cylinder A4504, thus retracting the mast assembly.
- c. GN<sub>2</sub> at 750 psig also flows through Pressure Regulator A4522, Relief Valve A4520, and Check Valve A4519 to the erect port of the Retract Cylinder A4504 to provide 180-psig GN<sub>2</sub> for mast deceleration and cushioning.
- d. As the mast reaches the maximum retracted position, the mast arrestor latches, preventing the mast from rebounding into the vehicle flight path or falling forward should pneumatic failure occur.

## 4. HOLDDOWN ARMS

### 4.1. Holddown Arm Description

Eight identical holddown assemblies (figure 2) support the vehicle and prevent lift until receipt of the commit signal. One holddown-arm assembly is located under each main fin and stub fin.

The holddown arms are operated by 750-psig helium supplied from valve panel 10 through a panel on the launcher. The controlling solenoids in the

release panels are electrically connected to the sequencing computer within the launch control center for proper sequencing.

The holddown-arm assemblies are seven-foot-high, cast steel structures that are bolted to the launcher. Each consists primarily of an arm and two pin-jointed links. The arm (figure 6, page 43) is joined to the frame at pin joint "A," allowing the arm to pivot upward and away from the vehicle tie-down points. The other end of the arm is supported at joint "B" by an assembly composed of two pin-jointed links. These links are joined end to end and attached to the holddown frame at joint "D." The connecting joint between these two links (pin joint "C") is connected to a pneumatically-released ball-lock separator. The links are designed so that they slant inward toward the vehicle. The ball-lock separator assembly is equipped with a swivel nut, which moves the link assembly outward and imposes a preload against the outrigger support (pin joint "B"). When pneumatic pressure releases the ball-lock separator at pin joint "C," the reaction to the preload causes the holddown arm to rotate around its pivot point (pin joint "A"), thus releasing the vehicle. As the link assembly folds downward, rotating about joint "D," the lower link encounters a replaceable shear pin module which absorbs kinetic energy and decelerates the motion of the arms and links. Arm motion breaks contact with a microswitch, indicating in the launch control center that the holddown arms have released.

#### 4.2. Holddown Arm Operation (figure 6)

The operation of the holddown arms consists of: attachment of the arms to the vehicle, pressurization of the release panel, and release of the holddown arms for vehicle liftoff.

4.2.1. Release Panel Pressurization. After the holddown arms are attached to the vehicle holddown points and the prescribed preload is placed on the ball-lock device, the system is ready for pressurization as follows:

- a. Manual Valve A4444 on the holddown-arms release panel is opened, allowing 750-psig helium to flow from valve panel 10 through Check Valve A4443 into Pneumatic Accumulator A4441. The pressure within the system is indicated by Pressure Gage A4440.
- b. Pressure Switch A4418 actuates at approximately 625 psig to close a relay in the engine ignition arming circuitry.

4.2.2. Holddown-Arms Release. The holddown-arms release sequence is as follows:

- a. When the H-1 engines have reached rated thrust and the engine hydraulic system has reached operating pressure, a signal from the launch control center energizes Solenoid Valves A4416 and A4417 and allows 750-psig helium to flow from Pneumatic Accumulator A4441 and the 750-psig He supply to Manifold A5687.

- b. The 750-psig helium flows simultaneously from Manifold A5687 to each holddown-arm assembly. Because all holddown arms operate identically and simultaneously, the operation of only one arm is described. Helium flows to Quick-Release Mechanism A4400, located at fin I, through Manual Valve A4431. This releases the ball-lock separator and allows the preload on the holddown arm to force the holddown arm to the release position. The lower link of the holddown-arm assembly shears the pins in the shear pin module and comes to rest. Switch A4411 actuates the fin I release indicator in the launch control center.

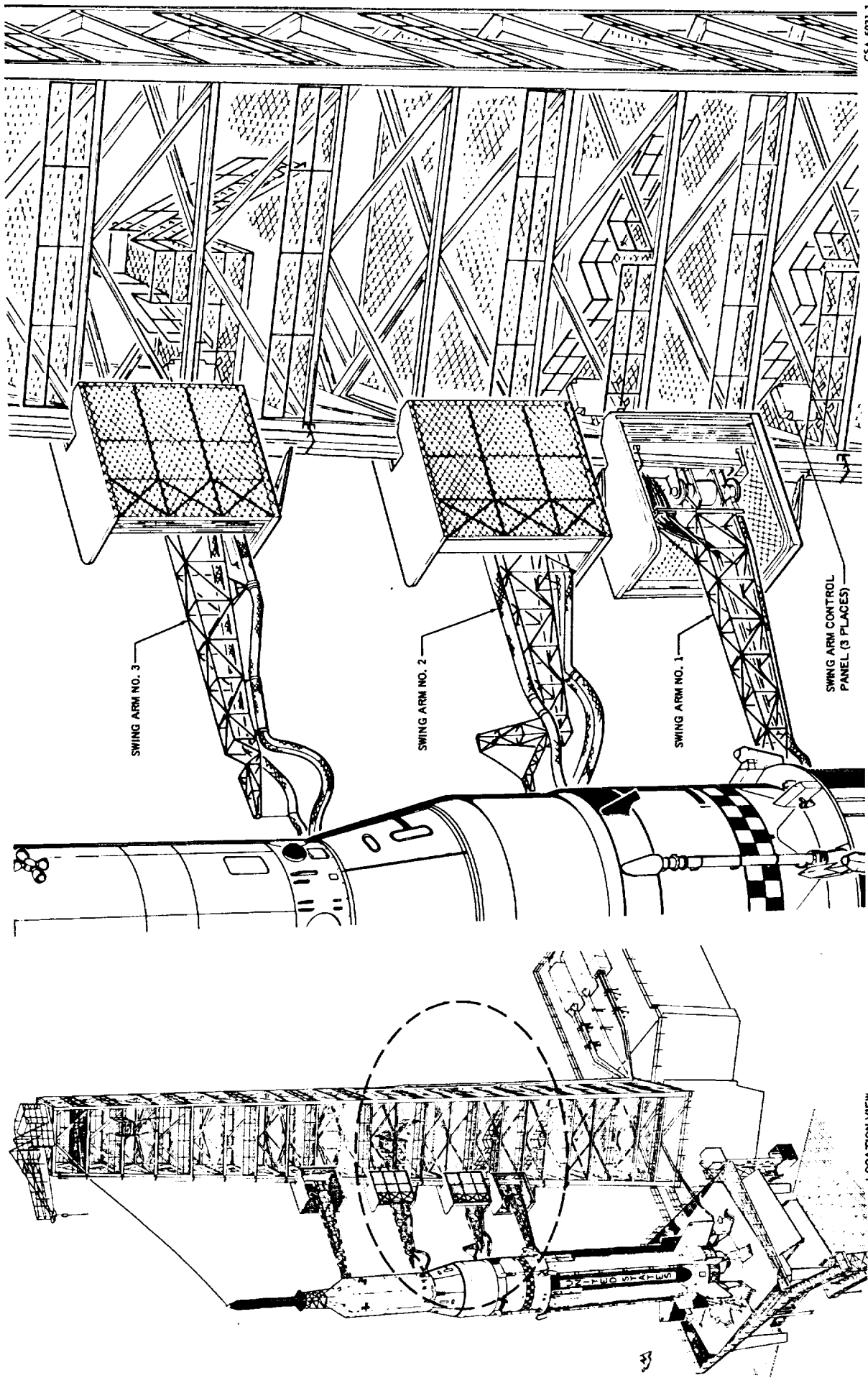


FIGURE 1. SWING ARMS

1000

1000

1000

1000

1000

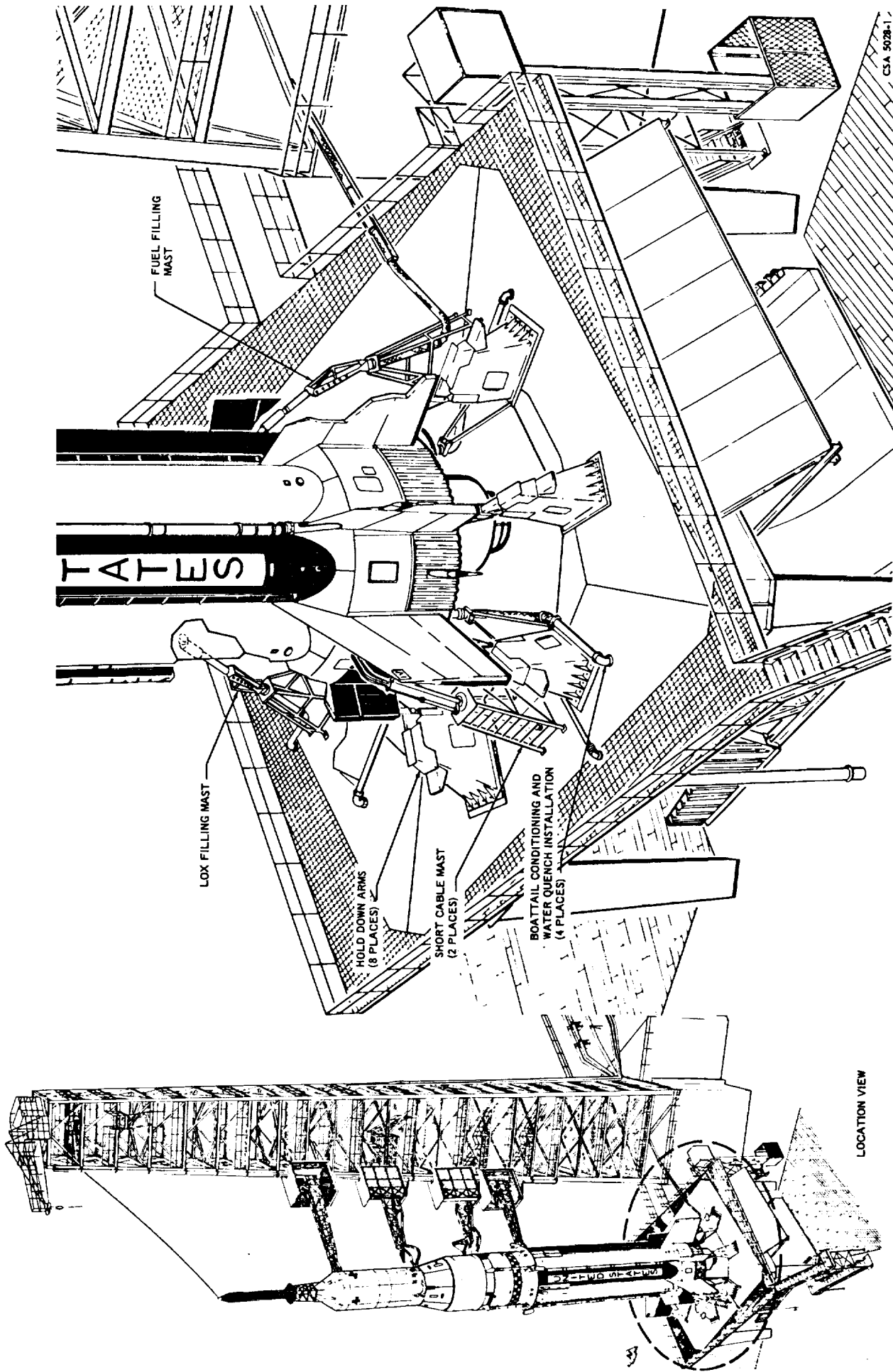


FIGURE 2. LAUNCHER



# LIST OF FINDING NUMBERS

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A3000	1	Accumulator, Hydraulic	1155 cu. in.	Parker Hydraulic Div., PN 1631-562212	75M-00453	
A3001	1	Valve, Manual	1/4 in.	Robbins Aviation Co. PN SSNA-250-4T-787	75M-01305-1	
A3002	1	Accumulator, Pneumatic	1190 cu. in. capacity	Parker Hydraulic Div. PN 1641-582082	75M-00449	
A3003	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc. PN 279T-6TT	75M-00452	
A3004	1	Valve, Check	3/4 in.	James, Pond & Clark, Inc. PN 279T-12TT	75M-00696	
A3005	1	Gage, Pressure	0-2000 psi	James P. Marsh Corp. Type 210	75M-50147-13	
A3006	1	Regulator, Pressure	Inlet Pressure - 6000 psig max. Outlet Pressure - 0-3500 psig	Grove Valve & Regulator Company, Model 15KX-10931MA2B	75M-50165-13	
A3007	1	Valve, Manual	1/4 in.	Robbins Aviation Co. PN SSNA-250-4T-787	75M01305-1	
A3008	1	Valve, Manual	4-Way, 3-Position, 3/8 in.	Parker Aircraft Co. PN H59E0023-1	75M-01949	
A3009	1	Valve, Button-Operated	1/4 in.	Futurecraft Valve Corp. PN 30130	75M-03568	
A3010	1	Valve, Ball, Manual	1 in.	Flodyne Controls, Inc. PN 10C12L	75M-00442	57A11A12
A3011	1	Hydraulic-Cylinder	2-in. bore, 48 inch stroke	Hannifan Company Model CBB-HLS13	10427203	

\* Location A = Ground; B = S-I stage; E = S-IV stage; G = Instrument Unit; H = Payload

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A3012	1	Valve, Ball, Pneumatic	1 in.	Flodyne Controls, Inc. PN 10C15	75M-00455	57A11A7
A3013	1	Actuator, Rotary Hydraulic	Torque, 210,000 in-lbs; Rotation, 290°	Exello Corp, Air & Hydraulic Engr. Co.	10428419	
A3014						
A3015						
A3016	1	Transducer, Pressure		Giannini Controls, Inc. PN 461267AD-G-200-20	75M-03149-1	57A11A15
A3017	1	Valve, Solenoid	3-Way, 2-Position (N.C.) 3/8 in.	Marotta Valve Corp. PN 204424 MV123	10425701	57A11A9
A3018	1	Valve, Solenoid	3-Way, 2-Position (N.C.) 3/8 in.	Marotta Valve Corp. PN 204424 MV123	10425701	
A3019	1	Valve, Manual	1/4 in., Vent	Robbins Aviation Co. PN SSNA-250-4T-787	75M01305-1	
A3020	1	Filter	12 GPM	Purolator Products Filter Element PN AN6235A4	MS 28920-12	
A3021	1	Hydraulic Lock-Pin Assembly	1500 psig operating press.		10427900	
A3022	1	Switch, Indicator		Parker-Hannifin Corp. PN MS 3102E-10SL-4P	75M05383	57A11A4
A3023	1	Valve, Ball, Mechanical	1 in.	Flodyne Controls, Inc. PN 10C17	75M03021	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A3024						
A3025						
A3026	1	Valve, Button-Operated	1/4 in.	Futurecraft Valve Corp. PN 30130	75M03568	
A3027	1	Valve, Check	Cracks at 0.1 to 1.0 psi 1/4 in.	James, Pond & Clark, Inc. PN 279-T-4TT	10425928-1	
A3028	1	Valve, Button-Operated	1/4 in.	Futurecraft Valve Corp. PN 30130	75M03568	
A3029						
A3030	1	Orifice	0.75 GPM at 900 psi, 70°F, 3/8" to 1/4" Union	A.U. Stone Company PN P883	75M-03155	
A3031	1	Valve, Check	1 in.	James, Pond & Clark, Inc. PN 279-T-16TT	75M-00189	
A3032	1	Valve, Ball, Cam-Operated	1 in.	Flodyne Controls, Inc. PN 10C19	75M-04253	
A3033 and A3034 are not functionally applicable to this system.						
A3035	1	Orifice	1/4" Union, 0.020 in. dia.	A.U. Stone Company PN H92C-020	75M-00456	
A3036	1	Valve, Ball, Pneumatic	1 in.	Flodyne Controls, Inc. PN 10C15	75M-00455	57A11A8

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A3037	1	Switch, Pressure		Southwestern Industries PN PS-3807-D625	75M-01965	57A11A3
A3038	1	Valve, Check	1 in.	James, Pond & Clark, Inc. PN 279-T-16TT	75M-00189	
A3039	1	Valve, Solenoid	3-Way, 2-Position (N.C.) 3/8 in.	Marotta Valve Corp. PN 204424 MV123	10425701	57A11A11
A3040	1	Orifice	5.0 SCFM	Del Manufacturing Co. PN DR4-5.0	75M-04000-18	
A3041	1	Valve, Solenoid	3-Way, 2-Position (N.C.) 3/8 in.	Marotta Valve Corp. PN 204424 MV123	10427701	57A11A13
A3042	1	Valve, Solenoid	3-Way, 2-Position (N.C.) 3/8 in.	Marotta Valve Corp. PN 304423 MV123-B	75M02986-1	
A3043	1	Valve, Solenoid	3-Way, 2-Position (N.C.) 3/8 in.	Marotta Valve Corp. PN 304423 MV123-B	75M-02986-2	57A11A17
A3044	1	Orifice	1/4 in., .060 in. dia.	A.U. Stone Company PN H92C-060	75M-02823	
A3045 and A3046 are not functionally applicable to this system.						
A3047	1	Switch, Pressure	Actuates at 0 psig Deactuates at 975 psi	Southwestern Industries PN PS-3807-D975	75M-03197-3	57A11A5
A3048 through A3059 are not functionally applicable to this system.						
A3060	1	Umbilical Housing Assembly			75M02049	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A3061 through A3066			are not functionally applicable to this system.			
A3067	1	Valve, Relief	Relieves at 2000 psi $\pm$ 100 Reseats at 1800 psi $\pm$ 50	James, Pond & Clark, Inc. PN 5159T-4TT-2000	75M06178-1	
A3068	1	Valve, Ball, Manual	1 in.	Flodyne Controls, Inc. PN 10C12R	75M00497	
A3069 through A3072			are not functionally applicable to this system.			
A3073	1	Orifice	0.031 in. Orifice dia. 1/4"	A. U. Stone Company PN H228-.031	75M50562	
A3074 and A3075			are not functionally applicable to this system.			
A3076	1	Orifice	1.2 SCFM at 70°F and 750 psi Upstream Pressure	Del Manufacturing Co. PN DR4-1.2	75M-04000-1	
A3077	1	Orifice	0.188 in. dia., 1" Union	Ausco, Inc. PN H264C-188	75M07280-1	
A3078	1	Orifice	0.156 in. dia., 1/2" Union	Ausco, Inc. PN H276-156	75M07281-1	
A3079 through A3099			are not functionally applicable to this system.			
A3100 through A3199 are the same and are in the same sequence as A3000 through A3099, with the exception of the following eight components: (Electrical symbols are the same except the first five digits are 57A12.						

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A3111	1	Cylinder, Hydraulic	1 3/8 in. bore 40.25 in. stroke	Hannifan Company Model CBB-HLS13	75M02818	
A3148	1	Valve, Solenoid	3-way, 2-position (N.C.) 3/8"	Marotta Valve Corp. PN 204424, MV123	10425701	57A12A19
A3149	1	Cylinder, Pneumatic			75M04725	
A3152	1	Cylinder, Pneumatic			75M04964	
A3153	1	Cylinder, Pneumatic			75M04964	
A3158	1	Umbilical Housing Assy.			75M04577	
A3179	1	Orifice	1 in. union 0.250 in. dia.	Ausco, Inc. PN H264C-250	75M07280-2	
A3180	1	Orifice	1/2" union 0.250 in. dia.	Ausco, Inc. PN H276C-250	75M07281-2	
A3200 through A3299 are the same and are in the same sequence as A3000 through A3099, with the exception of the following components: (Electrical symbols are the same except the first five digits are 57A13.)						
A3263	1	Valve, Solenoid	3-way, 2-position, (N.C.)	Marotta Valve Corp. PN 204424, MV-123	10425701	
A3284	1	Umbilical Housing Assy.			75M07037	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A3300	through	A4399	are not functionally applicable to this system.			
A4400	1	Quick Release Mechanism			75M01843	
A4401	and A4402	are not functionally applicable to this system.				
A4403	1	Quick Release Mechanism			75M01843	
A4404						
A4405	1	Quick Release Mechanism			75M01843	
A4406						
A4407	1	Quick Release Mechanism			75M01843	
A4408	1	Switch, Micro			75M02096	
A4409	1	Switch, Micro			75M02096	
A4410	1	Switch, Micro			75M02096	
A4411	1	Switch, Micro			75M02096	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A4412	through	A4415	are not functionally applicable to this system.			
A4416	1	Valve, Solenoid	3-way, 2-position (N.C.)	Marotta Valve Corp. Model MV526-B	75M03978	
A4417	1	Valve, Solenoid	3-way, 2-position (N.C.)	Marotta Valve Corp. Model MV526-B	75M03978	
A4418	1	Switch, Pressure	Act. on 625 inc. & 620 psig decr.	Southwestern Industries Inc., PN PS5116-D625	75M04207	
A4419	1	Quick Release Mechanism			75M01843	
A4420	1	Switch, Micro			75M02096	
A4421						
A4422	1	Quick Release Mechanism			75M01843	
A4423	1	Switch, Micro			75M02096	
A4424						
A4425	1	Quick Release Mechanism			75M01843	
A4426	1	Switch, Micro			75M02096	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A4427						
A4428	1	Quick Release Mechanism			75M01843	
A4429	1	Switch, Micro			75M02096	
A4430	1	Valve, Check	Cracks at 0.5 to 1.0 psi, 3/8 in.	James, Pond & Clark, Inc. PN 279T-6TT	75M040491	
A4431	1	Valve, Manual	1/2 in.	Flodyne Controls, Inc. Model 5A10	75M02297	
A4432	1	Valve, Manual	1/2 in.	Flodyne Controls, Inc. Model 5A10	75M02297	
A4433	1	Valve, Manual	1/2 in.	Flodyne Controls, Inc. Model 5A10	75M02297	
A4434	1	Valve, Manual	1/2 in.	Flodyne Controls, Inc. Model 5A10	75M02297	
A4435	1	Valve, Manual	1/2 in.	Flodyne Controls, Inc. Model 5A10	75M02297	
A4436	1	Valve, Manual	1/2 in.	Flodyne Controls, Inc. Model 5A10	75M02297	
A4437	1	Valve, Manual	1/2 in.	Flodyne Controls, Inc. Model 5A10	75M02297	
A4438	1	Valve, Manual	1/2 in.	Flodyne Controls, Inc. Model 5A10	75M02297	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A4439	1	Valve, Shuttle	1 in.		75M03977	
A4440	1	Gauge, Pressure	750 psi, 0-1500 psi range, 1/4 inch		75M04208	
A4441	1	Accumulator, Pneumatic	400 cu. in.		75M03975	
A4442	1	Valve, Manual	1/2 inch	Flodyne Controls, Inc. Model 5A10	75M02297	
A4443	1	Valve, Check	Cracks at 0.5 to 1.0 psi, 1/2 inch	James, Pond & Clark, Inc. PN 279-T-6TT	75M04049-2	
A4444	1	Valve, Manual	1/2 inch	Flodyne Controls, Inc. Model 5A10	75M02297	
A4445 through A4499		are not functionally applicable to this system.				
A4500	1	Retractable Coupling Assembly		Flexonics, Inc. PN 107435	10426984	
A4501						
A4502	1	Cylinder, Pneumatic	4 in. stroke, 1-1/2 in. bore	Tomkins-Johnson Co. PN LSM-3-750	10426944	
A4503	1	Cylinder, Pneumatic	4 in. stroke, 1-1/2 in. bore	Tomkins-Johnson Co. PN LSM-3-750	10426944	
A4504	1	Retract Assembly		MSFC	10426689	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A4505 through A4507			are not functionally applicable to this system.			
A4508	1	Cylinder, Pneumatic				
A4509 and A4510			are not functionally applicable to this system.			
A4511	1	Valve, Button-Operated	1/4 in.	Futurecraft Co. PN 30130	10425920	
A4512	1	Valve, Button-Operated	3/8 in.	James, Pond & Clark, Inc. PN 239T-6TT	10426693	
A4513	1	Orifice, Reducer	Orifice Diameter, .030 in. 3/8 in.	A.U. Stone Company PN 883-1	10426711	
A4514	1	Valve, Button-Operated	1/4 in.	Futurecraft Company PN 30130	10425920	
A4515	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN 239T-6TT	10426693	
A4516	1	Valve, Button-Operated	1/4 in.	Futurecraft Co. PN 30130	10425920	
A4517	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN 239T-6TT	10426693	
A4518	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN 239T-6TT	10426693	
A4519	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN 239T-6TT	10426693	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A4520	1	Valve, Relief	400 $\pm$ 25 psig Relief, 325 psig Min. Reseat	Cornelius Company PN 118-B-100-16	10426704	
A4521	1	Valve, Button-Operated	1/4 in.	Futurecraft Company PN 30130	10425920	
A4522	1	Regulator, Pressure	1/4 in., 750 psig Inlet, 185 $\pm$ 3 psig Outlet	Futurecraft Company PN 40170-1	10426705	
A4523	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN 239T-6TT	10426693	
A4524	through A4526 are not functionally applicable to this system.					
A4527	1	Orifice	.030 in. dia.	A. U. Stone Company PN H93C-.030	10426725	
A4528	through A4599 are not functionally applicable to this system.					
A4600	1	Retractable Coupling Assembly		Flexonics, Inc. PN 107435	75M-00253	
A4601	1	Cylinder, Pneumatic		Tomkins-Johnson Co. PN LSM-3-750	75M-00248	
A4602	1	Cylinder, Pneumatic		Tomkins-Johnson Co. PN LSM-3-750	75M-00248	
A4603	1	Retract Assembly		MSFC	10426689	
A4604 and A4605	are not functionally applicable to this system.					

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A4606	1	Assembly, Cylinder				
A4607		through A4610 are not functionally applicable to this system.				
A4611	1	Valve, Button-Operated	1/4 in.	Futurecraft Company PN 30130	10425920	
A4612	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN 239T-6TT	10426693	
A4613	1	Orifice	Orifice dia., .030 in. 3/8 in.	A. U. Stone Company PN 883-1	10426711	
A4614	1	Valve, Button-Operated	1/4 in.	Futurecraft Company PN 30130	10425920	
A4615	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN 239T-6TT	10426693	
A4616	1	Valve, Button-Operated	1/4 in.	Futurecraft Company PN 30130	10425920	
A4617	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN 239T-6TT	10426693	
A4618	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN 239T-6TT	10426693	
A4619	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN 239T-6TT	10426693	
A4620	1	Valve, Relief	400 $\pm$ 25 psig Relief, 325 psig Min. Reseat	Cornelius Company PN 118-B-100-16	10426704	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A4621	1	Valve, Button-Operated	1/4 in., Vent	Futurecraft Company PN 30130	10425920	
A4622	1	Regulator, Pressure	1/4 in., 750 psig Inlet, 185 -0 psig Outlet	Futurecraft Company PN 40170-1	10426705	
A4623	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN 239T-6TT	10426693	
A4624 through A4626 are not functionally applicable to this system.						
A4627	1	Orifice	0.030 in. dia.	A. U. Stone Company PN H93C-.030	10426725	
A4628 through A4849 are not functionally applicable to this system.						
A4850	1	Supply, Hydraulic		Sun Electric Company	75M00566	
A4851	1	Reservoir, Auxiliary				
A4852	1	Filter		Sun Electric Company		
A4853 through A5499 are not functionally applicable to this system.						
A5500	1	Valve, Ball, Manual		Hydromatics, Inc. PN 715C-2	10436216-3	
A5501	1	Valve, Ball, Manual		Hydromatics, Inc. PN 715	10436216-3	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A5502	1	Valve, Ball, Manual		Hydromatics, Inc. PN 715	10436216-3	
A5503 through A5546			are not functionally applicable to this system.			
A5547	1	Valve, Check	Cracks at 1 to 28 in. H <sub>2</sub> O (VAC) 2-1/2 in.	Valve and Primer Corp. PN S1224	75M04003	
A5548 through A5600			are not functionally applicable to this system.			
A5601	1	Valve, Solenoid	3-way, 2-position (N.C.) 3/8 in.	Marotta Valve Corp. PN 204424 MV 123	10425701	53A70A2
A5602	1	Valve, Solenoid	3-way, 2-position (N.C.) 3/8 in.	Marotta Valve Corp. PN 204424 MV 123	10425701	53A31A1A2
A5603	1	Valve, Solenoid	3-way, 2-position (N.C.) 3/8 in.	Marotta Valve Corp. PN 204424 MV 123	10425701	53A31A1A3
A5604	1	Valve, Solenoid	3-way, 2-position (N.C.) 3/8 in.	Marotta Valve Corp. PN 204424 MV 123	10425701	53A64A1
A5605	1	Valve, Solenoid	3-way, 2-position (N.C.) 3/8 in.	Marotta Valve Corp. PN 204424 MV 123	10425701	53A32A1A3
A5606	1	Valve, Solenoid	3-way, 2-position (N.C.) 3/8 in.	Marotta Valve Corp. PN 204424 MV 123	10425701	53A321A4
A5607 through A6499			are not functionally applicable to this system.			
A6500	1	Quick - Disconnect and Release Pin Assembly			75M02855	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A6501 through A6510			are not functionally applicable to this system.			
A6511	1	Cylinder, Pneumatic		Parker Hydraulics Div., PN 1641-582082	75M02614	
A6512 and A6513			are not functionally applicable to this system.			
A6514	1	Valve, Check	1/4 in.	James, Pond & Clark, Inc., PN HP279T1-4BT	75M02661	
A6515						
A6516	1	Orifice	0.015 dia., Union 1/4 in.	A.U. Stone Company PN H92C-.015	75M02852	
A6517	1	Valve, Check	1/4 in.	James, Pond & Clark, Inc., PN HP279T1-4TT	75M02675	
A6518	1	Regulator	Inlet Pressure: 3000 psig Outlet Pressure: 15-75 psig	Futurecraft Company PN 40051-4	75M02663	
A6519						
A6520	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN HP279T1-6TT	75M02676	
A6521						
A6522	1	Cylinder, Pneumatic		Parker Hydraulics Div.	75M02697	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A6523	1	Valve, Relief	Relieves at 3 psi 1/4 in.	James, Pond & Clark, Inc., PN P 4-698-3	75M00178	
A6524			A6524 and A6525 are not functionally applicable to this system.			
A6526	1	Cylinder, Pneumatic		Parker Hydraulics Div., PN 1641-582082	75M02614	
A6527			A6527 through A6599 are not functionally applicable to this system.			
A6600	1	Release pin		E. B. Wiggins Co.	75M02855	
A6601			A6601 through A6610 are not functionally applicable to this system.			
A6611	1	Cylinder, Pneumatic		Parker Hydraulics Div., PN 1641-582082	75M02614	
A6612			A6612 and A6613 are not functionally applicable to this system.			
A6614	1	Valve, Check	1/4 in.	James, Pond & Clark, Inc., PN HP 279T1-4BT	75M02661	
A6615						
A6616	1	Orifice	.015 dia., Union 1/4 in.	A. U. Stone Company, PN H92C-.015	75M02852	
A6617	1	Valve, Check	1/4 in.	James, Pond & Clark, Inc., PN HB279T1-4TT	75M02675	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A6618	1	Regulator	Inlet Pressure: 3000 psig Outlet Pressure: 15-75 psi	Futurecraft Company, PN 40051-4	75M02663	
A6619						
A6620	1	Valve, Check	3/8 in.	James, Pond & Clark, Inc., PN HP279T1-6TT	75M02676	
A6621						
A6622	1	Cylinder, Pneumatic		Parker Hydraulics Div.	75M02697	
A6623	1	Valve, Relief	Relieves at 3 psi 1/4 in.	James, Pond & Clark, Inc., PN P-4-698-3	75M00178	
A6624 and A6625			are not functionally applicable to this system.			
A6626	1	Cylinder, Pneumatic		Parker Hydraulics Div., PN 1641-582082	75M02614	
A6627 through A7199			are not functionally applicable to this system.			

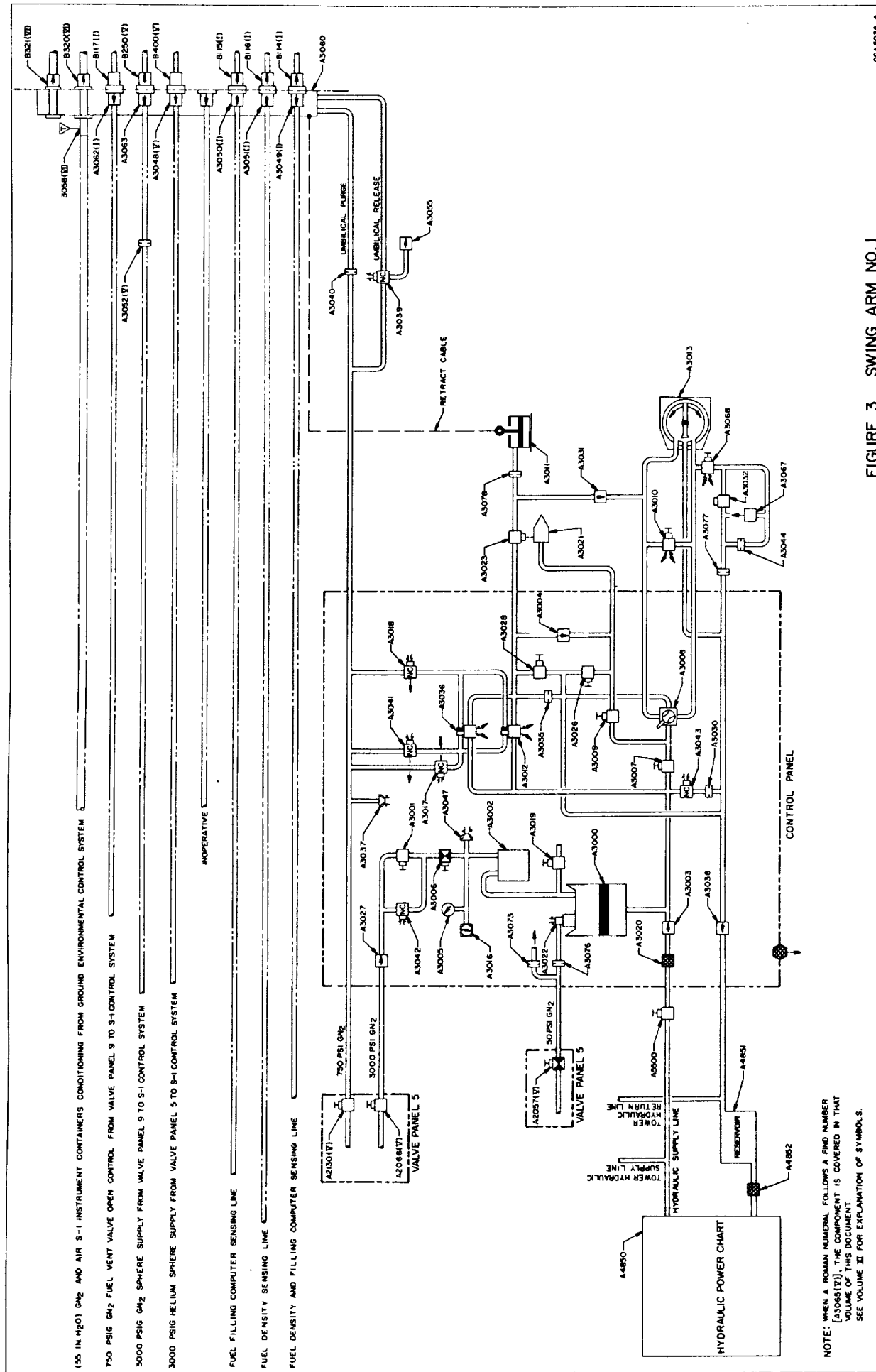


FIGURE 3. SWING ARM NO. 1

NOTE: WHEN A ROMAN NUMERAL FOLLOWS A FIND NUMBER [A3065(1)], THE COMPONENT IS COVERED IN THAT VOLUME OF THIS DOCUMENT. SEE VOLUME II FOR EXPLANATION OF SYMBOLS.



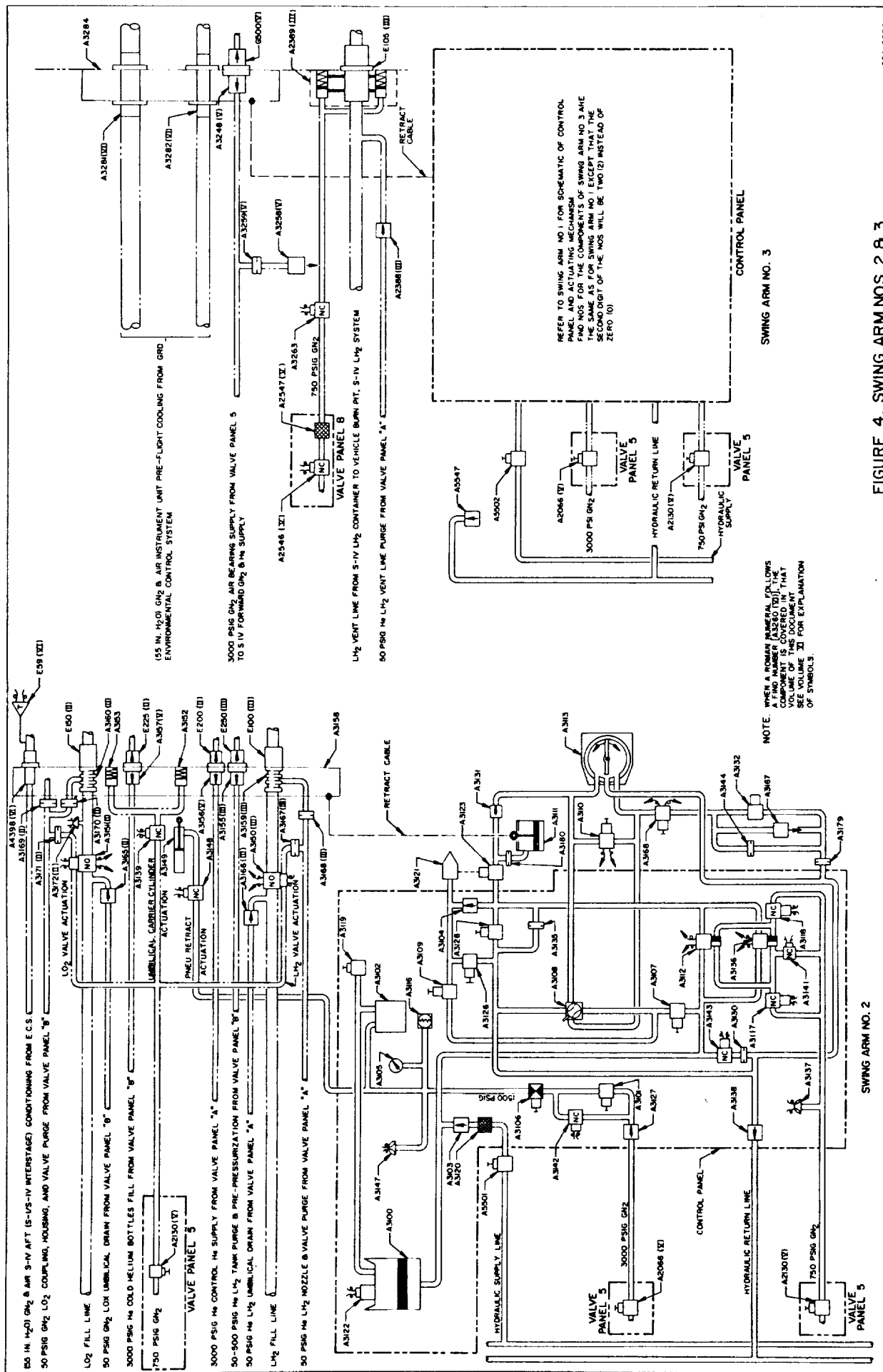
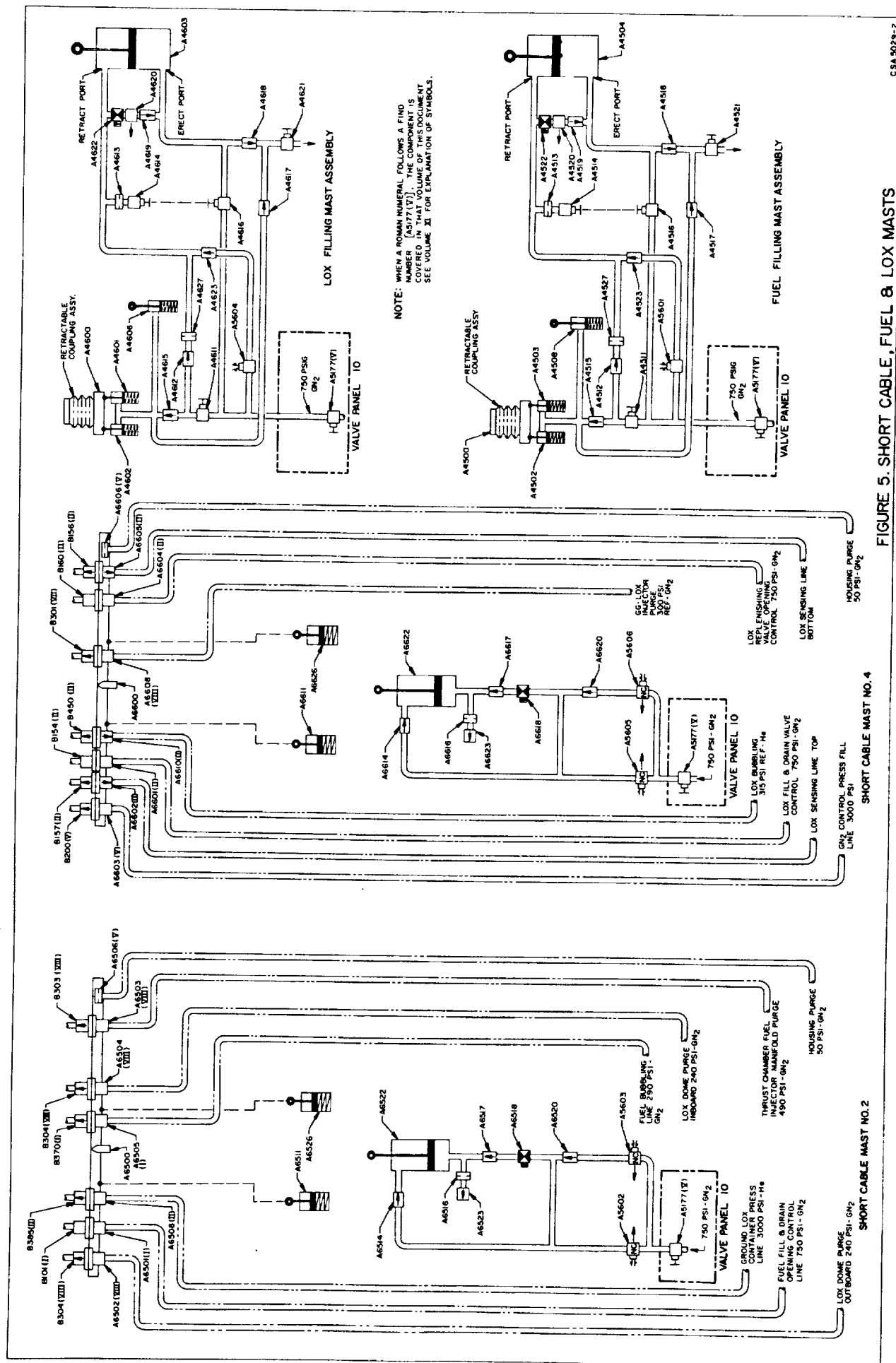


FIGURE 4. SWING ARM NOS. 2 & 3





**FIGURE 5. SHORT CABLE, FUEL & LOX MASTS**



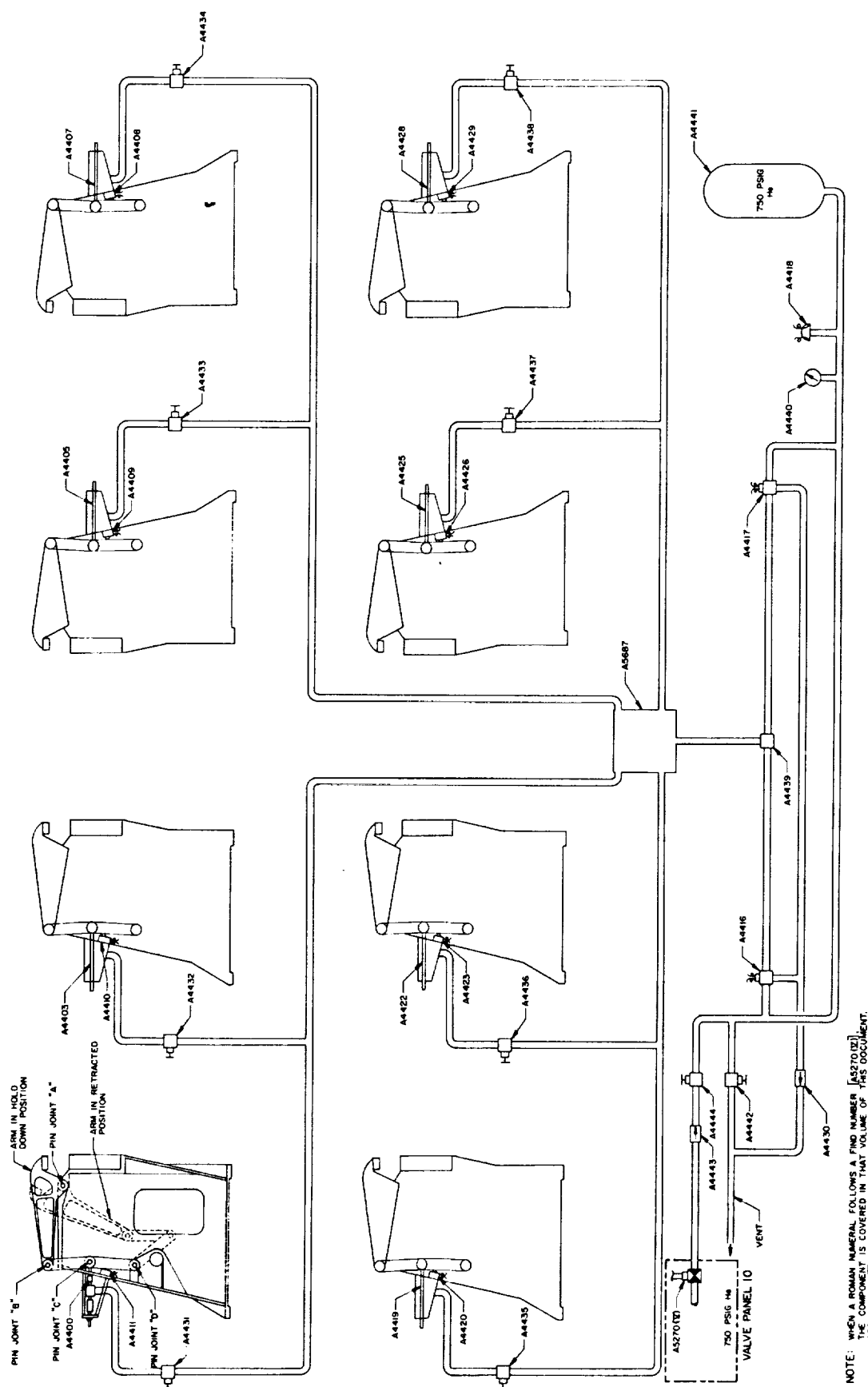


FIGURE 6. HOLD DOWN ARMS & RELEASE CONTROL PANEL



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KN-DE2, MOORE, R.	R-ASTR-ES, ADEN, R. (3)
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KN-DE2, CHAPPLE, E.	R-ASTR-I, HOBERG, O.
KN-DE4, DOWNS, J.	R-ASTR-IM, POWELL, J.
KN-DE5, GRIFFIN, F.	R-ASTR-TR, WAGNON, W.
KN-DF2, CAREY, T.	R-ME-A, NOWAK, M.
KN-DL2, BUCHANAN, D.	R-P&VE-AV, NEIGHBORS, W.
KN-DP2, MIMS, W.	R-P&VE/DAC, MEZO, C.
KN-DP2, MINTON, C.	R-P&VE-PA, REED, K.
KN-DP2, SPARKMAN, O.	R-P&VE-PEM, HOLMES, J. (2)
KN-DP2, WASILESKI, C.	R-P&VE-PM, FUHRMANN, H. (2)
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KN-DR2, HOOKER, J. (5)	R-P&VE-V, PALAORO, H.
KN-DS232, BUNCH, M.	R-P&VE-VA, HOFFMAN, C.
KN-ET, BRIDEWELL, C.	R-P&VE-VAS, MOON, O.
KN-FE, DODD, R. (2)	R-P&VE-VF, ROTHE, K.
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